

CLAIMS

1. A method of manufacturing a semiconductor, the method comprising:
forming gate lines on a semiconductor substrate;
forming a first insulating layer between the gate lines;
5 forming first contact pads and second contact pads in the first insulating layer and
between the gate lines, the first and second contact pads a surface of the semiconductor
substrate;
forming a second insulating layer overlying the first and second contact pads;
forming bit lines on the second insulating layer, the bit lines electrically connected to
10 the second contact pads and extending across the gate lines;
forming a third insulating layer overlying the bit lines; and
forming band-type openings by selectively etching a portion of the third insulating
layer, wherein the band-type openings extend in a lengthwise direction of the gate lines to
expose the first contact pads, and wherein the band-type openings have portions that protrude
15 in a lengthwise direction of the bit lines.
2. The method of claim 1, further comprising:
forming a conductive layer on the third insulating layer, wherein the conductive layer
fills the band-type openings and is electrically connected to the first contact pads;
20 separating the conductive layer into individual storage node contact bodies; and
forming storage nodes on the storage node contact bodies.
3. The method of claim 1, wherein the protruding portions are positioned
between the bit lines.
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4. The method of claim 3, wherein the protruding portions comprise a triangular
with vertices disposed between the bit lines.
5. The method of claim 1, wherein the protruding portions comprise adjacent
30 protruding portions protrude in opposite directions and each bit lines is positioned between
the adjacent protruding portions.

6. The method of claim 1, wherein the openings has a bottom portion with a line width less than a line width of an upper portion of the openings so as to have oblique sidewalls.

5 7. The method of claim 6, wherein the upper portion of the openings overlaps an upper portion of the gate lines at the protruding portions.

8. The method of claim 6, wherein the upper portion of the openings partially overlaps an upper portion of the second contact pads at the protruding portions.

10 9. The method of claim 6, wherein forming band-type openings comprises taper etching to make the sidewalls of the openings oblique.

10. The method of claim 1, wherein forming band-type openings comprises
15 forming band-type openings that extend across and expose the bit lines.

11. The method of claim 1, further comprising:
forming a capping insulating layer overlying the bit lines; and
forming spacers to cover the sidewalls of the bit lines.

20 12. The method of claim 11, further comprising forming a conductive layer on the third insulating layer, wherein the conductive layer fills the band-type openings and is electrically connected to the first contact pads, wherein forming the conductive layer comprises planarizing the conductive layer until the upper surface of the capping insulating
25 layer is exposed.

13. A method of manufacturing a semiconductor device, the method comprising:
forming gate lines on a semiconductor substrate;
forming a first insulating layer between the gate lines;
30 forming first contact pads and second contact pads between the gate lines and in the first insulating layer to be electrically connected to a surface of the semiconductor substrate;
forming a second insulating layer overlying the first and second contact pads;

forming bit lines on the second insulating layer, the bit lines extending across the gate lines and electrically connected to the second contact pads through the second insulating layer;

forming a third insulating layer overlying the bit lines;

5 forming zigzag-shaped band-type openings by selectively etching a portion of the third insulating layer, wherein the band-type openings extend in a lengthwise direction of the gate lines to expose the first contact pads;

forming a conductive layer on the third insulating layer to fill the band-type openings, the conductive layer electrically connected to the first contact pads;

10 separating the conductive layer into individual storage node contact bodies; and forming storage nodes on the storage node contact bodies.

13. The method of claim 12, wherein the band-type openings have a pair of a protruding portion and a concave portion, in a lengthwise direction of the bit lines, the
15 protruding portion facing the concave portion between the bit lines.

14. The method of claim 12, wherein forming band-type openings comprises forming band-type openings that are serpentine in shape, wherein an outermost and innermost edge of the band-type openings are positioned between the bit lines.

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15. The method of claim 12, wherein the openings has a bottom portion with a line width that is less than a line width of an upper portion of the openings so as to have oblique sidewalls.

25 16. The method of claim 15, wherein the openings extend such that the upper portion of the openings overlaps an upper portion of the gate lines at the protruding portions.

17. The method of claim 15, wherein the openings extend such that the upper portion of the openings partially overlaps an upper portion of the second contact pads,
30 between which each gate line is positioned, at the protruding portions.

18. The method of claim 15, wherein forming band-type openings comprises using taper etching to make the sidewalls of the openings oblique.

19. The method of claim 12, further comprising:
forming a capping insulating layer to cover the bit lines; and
forming spacers to cover the sidewalls of the bit lines.

5 20. The method of claim 19, wherein forming the conductive layer comprises
planarizing the conductive layer until the upper surface of the capping insulating layer is
exposed.

10 21. The method of claim 12, wherein forming storage nodes on the storage node
contact bodies comprises forming adjacent storage nodes, between which each bit line is
positioned, the storage nodes arranged in a direction diagonal to the lengthwise direction of
the bit line.

15 22. The method of claim 12, wherein the storage nodes are formed in the shape of
cylinders having circular or rectangular areas.

 23. The method of claim 22, further comprising forming a buffer layer to cover
lower sides of the cylindrical storage nodes.

20 24. The method of claim 12, wherein an edge-to-edge width of the band-type
openings is constant, and wherein a position of the edges of the band-type openings varies
along the lengthwise direction of the gate lines.